Gulf of Mexico Alliance White Paper
Reductions in Nutrient Loading to the Gulf of Mexico
May 26, 2005

Problem Statement/Goal

Estuaries and near coastal waters provide critical habitats that support wildlife and fisheries and contribute substantially to the economy of the United States (CCRII, 2005). The introduction of excess nutrients into the estuaries and waters of the Gulf of Mexico is one of the primary problems facing the coastal areas of the five Gulf States (Texas, Louisiana, Mississippi, Alabama and Florida). According to the EPA's 1996 Report to Congress, 57% of estuaries were impaired by excess nutrients and estimates from the 2001 National Coastal Condition Report are that 40% of the total estuarine surface area in the United States exhibit degraded eutrophic conditions. Nutrients have been consistently ranked as one of the top three causes of use impairment in U.S. waters for more than a decade. Excess nitrogen and phosphorus originating upstream from man-made sources such as wastewater treatment plants, industrial discharges, and urban and agricultural runoff are carried in river water and by atmospheric deposition to the estuaries and open waters of the Gulf. The nutrient over-enrichment and resulting changes in nutrient ratios can cause habitat loss, depletion of dissolved oxygen, and the gradual decline of important marine organisms. A collaborative Gulf-wide nutrient reduction strategy is imperative to the well-being of the Gulf, the health of humans living in the area, and the economic future of the States. Partnerships between the Gulf States, Federal government and local communities will help address the nutrient problem and propose solutions from an ecoregional standpoint, rather than from separate perspectives.

Background

About two-thirds of the surface area of the continental United States, approximately 1.25 million square miles and 33 major rivers drain into the Gulf of Mexico. The Mississippi River is the largest single source of nitrogen, phosphorus, silica and organic matter to the northern Gulf. The watershed is home to much of the nation's prime agricultural land. Although most of the nitrogen and phosphorus fertilizers used on these lands are absorbed by the crops they were intended for, as much as 20% can leach into the groundwater or flow directly into surface water, eventually making their way to the Gulf of Mexico. A recent study (Goolsby *et al*., 1999) showed that most of the nitrogen loading from the greater Mississippi River basin, i.e., 89%, can be attributed to nonpoint sources including fertilizer, erosion, groundwater discharge, animal waste and atmospheric deposition. The remaining (11%) is derived from municipal and industrial point sources. Phosphorus inputs to the Gulf of Mexico come from fertilizers (31%), animal waste (18%), point sources (10%), and generalized basin runoff (including soil erosion) (41%). Another study (NRC, 2000) approximated that humans have increased nitrogen inputs to the Gulf of Mexico by 275% compared to pre-developed levels.

Among the other major U.S. Rivers that flow into the Gulf are Florida's Suwannee and Apalachicola, Alabama's Mobile, Mississippi's Pascagoula, Louisiana's Pearl and Atchafalaya,

and Texas's Sabine, Trinity, and Brazos. Between 1960 and 2000, the combined population of counties along the Gulf Coast increased more than 100%, from 8 million to over 17 million, which has led to increases in nutrient loading to the Gulf.

Nitrogen and phosphorus are naturally occurring nutrients that, if excessively increased, have the potential to adversely impact an aquatic ecosystem. Cultural eutrophication, one of the most common consequences of nutrient over-enrichment, is defined as an increase in the production of organic matter (e.g., phytoplankton and macroalgae). In coastal waters of the Gulf, cultural eutrophication is most often due to increases in growth-limiting nutrients. Increases in the growth-limiting nutrient increases those organisms that respond quickly to the food source, increasing the growth of phytoplankton and/or macrophytes, which die and decompose. The decomposition of this organic matter can lead to lower dissolved oxygen (DO) levels, particularly in bottom waters. DO levels that are too low can cause mortality in aquatic organisms. The large Gulf of Mexico Hypoxic Zone, near the mouth of the Mississippi River, is the most dramatic example of this effect, which is primarily due to a combination of excess nutrient loading from the Mississippi River and stratified conditions in nearshore Gulf waters. Hypoxic conditions can cause direct mortality of fish and their prey, reduce suitable habitat, and generally disrupt basic processes such as reproduction, migration, recruitment and food web dynamics. When the Gulf food web is impacted, the fishing industry suffers when important commercial species are no longer abundant. Research has shown that brown shrimp (the most important commercial species in the Gulf) catch levels are inversely correlated with hypoxia extent and severity.

Nutrient over-enrichment contributes to the loss of seagrass beds, which provide important nursery and feeding resources for many ecologically and economically important marine and estuarine species. The loss of seagrass beds and other submerged benthic habitats is likely caused by macroalgae "smothering" and decreased light penetration due to increased levels of phytoplankton in the water column. While the distribution of seagrass beds and other benthic habitats has significantly decreased along the Gulf coast in recent years due at least in part to nutrient over-enrichment and other water quality degradation (NRC 2000), the role of turbidity and its effect on light penetration and interaction with nutrients in terms of limiting or stimulating primary production is unclear. Data and research is needed to clarify this relationship.

Human health can also be adversely impacted by excess nutrients in coastal waters. Some phytoplankton species that can dominate when a system contains too many nutrients are toxic to aquatic organisms and humans, leading to harmful algal blooms (HABs). Altered ratios of nitrogen, phosphorus, and silica are also hypothesized to be partly responsible for increased harmful and nuisance blooms.

Strengths/Progress

There has been considerable effort focused on the northern Gulf hypoxic zone. On January 16, 2001, EPA sent to congress the final *Action Plan for Reducing, Mitigating and Controlling Hypoxia in the Northern Gulf of Mexico.* The Action Plan was the result of work done by the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, made up of representatives

from nine States, two Tribes and nine Federal agencies. In addition the Task Force has developed *A Science Strategy to Support Management of Decisions Related to Hypoxia in the Northern Gulf of Mexico and Excess Nutrients in the Mississippi River Basin*. The 2000 Farm Bill has poured millions of dollars into conservation practices that are improving conditions, and NRCS is working with environmental agencies to better utilize the resources of the Farm Bill.

Each of the Gulf States has different strengths regarding the abatement and monitoring of nutrient loading to the Gulf of Mexico. Texas, for example, has extensive coastal water quality baseline data, due to the efforts of the state's Commission on Environmental Quality (TCEQ) and other monitoring groups (e.g., Clean Rivers, Texas Parks and Wildlife Department). TCEQ and its partners have developed a coordinated sampling system that promotes efficiency and reduces duplicated sampling efforts. Alabama approaches surface water quality monitoring from a sub-watershed level, identifying priority areas on which to concentrate in more detail. The Alabama Monitoring and Assessment Program (ALAMAP) conducts sampling at numerous coastal stations on a monthly basis in an effort to characterize estuarine water quality; upland stream sampling stations are also monitored. Alabama's Nonpoint Source Assessment Program develops intensive watershed assessments to gauge how nonpoint sources are impacting a given basin and its response to management practices. Alabama also has an extensive volunteer monitoring network that is very active in coastal areas as well as within specific watersheds.

The Louisiana non-point program has supported the development of nutrient best management practices to reduce the runoff of nutrients into State waters. In addition LADEQ has been an invited member of the NRCS Technical Committee which selects priority areas for use of Farm Bill resources. Among the factors NRCS has agreed to use for selecting priority areas for resources is Louisiana's list of impaired waters.

EPA has developed a national nutrient strategy whereby all states and tribes are to adopt nutrient water quality criteria as a part of their water quality standards and many of the states are working toward the development of nutrient criteria. The Texas Commission on Environmental Quality issued a draft "Nutrient Criteria Development Plan" on December 20, 2004 and expects to have draft criteria proposals for selected priority reservoirs by the end of 2005. Although reservoirs are the priority in many of the Gulf States because of public health implications, states such as Texas have initiated simultaneous efforts to address criteria for rivers and streams as well as coastal and estuarine areas. Texas expects to begin implementing nutrient criteria by 2010. Alabama has already made significant progress in developing nutrient criteria for 24-40 reservoirs; subsequent criteria development will focus on streams and rivers and coastal and estuarine areas, in that order. Florida is also in the process of developing nutrient criteria for lakes and streams under a plan submitted to EPA, primarily by identifying reference areas, collecting relevant historical data and assessing its quality, and developing a nutrient/dissolved oxygen monitoring study for some of the water bodies to fill in data gaps. Mississippi is in the process of collecting data for use in developing nutrient criteria. Louisiana has recently completed a detailed plan for developing nutrient criteria that is currently under review. The plan highlights the ongoing programs for monitoring, assessment, and nutrient reductions.

States and EPA are developing Total Maximum Daily Loads (TMDLs) for nutrient impaired waters to address the nutrient impairments and progress is being made. The development of

TMDLs is accompanied by the development of nutrient load reduction strategies to achieve the TMDL.

Nutrient Management at the Local Scale

Many coastal areas of the Gulf are affected by more localized sources of nutrients. These include: Tampa Bay, the Suwannee River Estuary, Perdido Bay, Escambia Bay, Caloosahatchee River, Sarasota Bay, and others. Much of the work to quantify nutrient inputs to the Gulf has been focused on the Mississippi River Basin, however, additional resources are needed to better assess the other inputs to the Gulf. Many of these more localized nutrient issues have been the subject of significant research, modeling and monitoring. The use of Best Management Practices, creation or enhancement of adjacent wetlands, increased wastewater treatment and the relocation of effluents have proven to be effective in reducing nutrient loadings

The National Estuary Programs (NEP) located in the Gulf of Mexico can help forge partnerships between local, state, and federal stakeholders to address threats to the estuarine environments. Tampa Bay NEP, for example, has made great strides in developing nutrient management goals with the long-term goals of not only improving water quality, but also increasing seagrass habitat area in and around the Bay. An expected increase in local population density in the near future has been incorporated into the management objectives. Because Tampa Bay NEP is a partnership of governmental and nongovernmental agencies and organizations, the program has managed to develop collaborative working relationships that will benefit the health of the Bay and its resources. Texas has documented downward trends in nutrient and chlorophyll-a levels in Galveston Bay, in part due to the past achievements of point-source regulatory program and perhaps increased attention paid to the Bay through the Galveston Bay Estuary Program (GBEP). However, despite apparent downward trends, nutrient levels in some parts of the Bay remain above concern levels (Lester and Gonzalez, 2002).

Sarasota Bay has improved significantly as a result of nutrient management and community action including: consolidation, expansion and upgrades to wastewater treatment plants, and collection systems; water conservation; and the construction of reclaimed wastewater systems. It is estimated that nitrogen pollution from wastewater to Sarasota Bay has been reduced 85% with 50% of the wastewater reclaimed; and these actions combined with regional stormwater treatment have resulted in an estimated 50% reduction in overall nitrogen load since 1988. Seagrass coverage has substantially increased bay-wide, and expanded in 43% of the seagrass acreage accounted for (or in 4058 acres of the 9243 acres) in Sarasota Bay in 2003. The main Bay segments currently meet State water quality standards and have shown an increase in overall and continuous sea grass coverage over the 15 year period; more stringent marine standards for nutrients are presently being proposed by the State in several Bay segments. The Sarasota Bay Estuary Program (SBEP) is presently refining the nutrient management strategies to attain standards in a several tributaries and smaller embayments and is preparing management plans accordingly.

Challenges/Barriers

Addressing nutrient problems is challenging due to the scale and complexity of the problem. Natural nutrient conditions are tremendously variable, so it is sometimes difficult to differentiate cultural eutrophication from natural conditions. Point, nonpoint and atmospheric nutrient sources are also highly variable spatially and temporally. In some cases (e.g. the Mississippi River), nutrient sources cannot be reduced sufficiently by local programs, since many of the sources of the nutrient loading are from upstream states. With tight fiscal constraints and competing priorities at both the state and federal level, state and federal agencies will need to be resourceful and efficient to properly address the problem.

The starting point to address nutrient problems is data assessment. While considerable monitoring has taken place, there are currently insufficient data to adequately characterize nutrient and biological conditions for many water bodies. It is essential that data be of the highest quality to achieve the objectives of the Gulf States' programs. Most of the monitoring is done at the local level, which creates the potential for data comparability issues unless there are comparable detection limits and quality assurance procedures in place. As a result, the Gulf States are currently struggling to ensure that data are of a sufficiently high quality to achieve the objectives of their nutrient programs. There is a consensus that STORET does not contain sufficient data quality information and that much of the data in STORET is of insufficient quality to meet data quality objectives nor does STORET contain sufficient metadata (information describing how and for what purpose data were collected) to assess the suitability of the data to secondary evaluations. Additionally, bioassessment tools are not available to quantify the degree of adverse biological response associated with a particular level of nutrient enrichment. Finally, there is a need for the development of tools to better understand the relationship between watershed land uses and the resulting nutrient problems in coastal waters.

Other challenges associated with nutrient load reductions covered a broad spectrum of issues. All five Gulf States identified the general problem of dealing with a rapidly increasing coastal population and the resulting increase in nutrient loading. Florida also has concerns about the many different agencies undertaking monitoring activities in the state and the problems associated with compiling all the data into one central location. Alabama expressed the concern that funding shortages limit the effectiveness and scope of their monitoring program.

Priorities

Reducing the impact of nutrients on our coastal waters will require coordinated state and federal actions, in addition to cost effective public-private partnerships. An adaptive approach that takes action, monitors the results, shares the information and makes adjustments is needed. Specific needs include:

- Resources for monitoring of nutrients and biological conditions to support the development of nutrient criteria for coastal waters: The biological monitoring should be designed to support the development of biological response criteria. The monitoring will also need to be of sufficient quality to support the data objectives of nutrient criteria establishment and nutrient load reduction efforts. It would probably be most efficient to

establish databases at the state level; however, the efforts should be coordinated to ensure consistency between the state databases. The database should also contain sufficient quality assurance data elements and descriptive metadata elements to evaluate the quality and applicability of the data. (The Gulf of Mexico Program Office plans to conduct a series of workshops with the states to achieve this). Additional quality assurance activities (planning, training, auditing, corrective actions) should occur throughout the process.

- Resources for the establishment of nutrient criteria for coastal waters: Since all Gulf States will be establishing nutrient criteria for coastal waters, it would be most efficient if these efforts could be coordinated by the USEPA. This would ensure consistent criteria between states and help in the approval process.
- Tools to better understand the relationship between watershed land uses and the resulting nutrient problem in coastal waters: This will help ensure the development of technically-rigorous TMDLs and cost-effective nutrient load reduction strategies.
- Assistance in implementing nutrient source reduction measures: The 2000 Farm Bill is a good start; however, additional resources are required to address the issue. Access to additional funds for agricultural nutrient reduction, wastewater treatment plant upgrades and urban stormwater management are needed. There should be more effective collaboration between the federal resource agencies and the state water quality agencies on establishing priorities for use of the available funds. All should support the implementation of the Action Plan that calls for new appropriations across the multiple federal agencies in support of state and local actions to reduce nutrient loads to the Mississippi River and the Gulf of Mexico.
- Funded environmental lands acquisition programs to establish urban buffers along waterways leading to the Gulf of Mexico as well as sites for filter marshes to reduce nutrient loads.
- Better standard practices for stormwater systems associated with the Federal-Aid Highway program. Assistance in pairing identified restoration priorities with water quality and wetland mitigation needs associated with federal infrastructure improvements such as the Federal-Aid Highway program.

Needs from State/Federal Partnership

A comprehensive and coordinated effort among federal, state and local entities to evaluate, and prioritize nutrient issues, and the development of strategies and the attaining of resources to reduce excess nutrients entering coastal waters are of the utmost importance. Resources are needed to expand monitoring efforts, as well as to increase technical and continual financial assistance.

The Gulf States would benefit from added assistance from the federal government in their attempts to address nutrient loading issues. In particular, the states need increased funding toward specific elements of nutrient load abatement and monitoring. Increased funding would allow more and better water quality and habitat data to be collected with the goal of developing appropriate nutrient criteria. Other programs that the federal government could fund would include the study of downstream effects of nutrient loading abatement and the cooperation of states to address shared water bodies, as described above. In particular, Texas would benefit

from improvements to water quality monitoring methodology as well as meshing the water quality monitoring program with the biological monitoring program. Florida would like to see a central repository for all Gulf-wide nutrient-related data. Currently, STORET is the only such system. Louisiana stresses the need to retain support from key agencies, such as the Gulf of Mexico Program, the National Hypoxia Task Force, and the Lower Mississippi River Conservation Committee. Continued assistance from such programs as the Environmental Leadership Program and the Nonpoint Source Program will be required to allow Louisiana to encourage municipalities, industries, and agriculture to reduce nutrient loads.

Governance Implications

Effective watershed or basin teams focused on the local water quality issues are essential to provide grassroots support for nutrient reduction. In addressing nutrient loading issues from an ecoregional perspective, changes in how states regulate nutrients, their sources, and their monitoring may develop. We have the tools, what we need are resources and the elimination of competing priorities.

Broader Implications

Addressing nutrient loading from a Gulf-wide perspective can benefit other aspects of the federal government's Ocean Action Plan. For example, in December 2004 the Oceans and Human Health Act was enacted and signed into law, authorizing a national research initiative into the relationships between oceans and human health. Although this research plan is still being developed, a partnership among the five Gulf States can facilitate data gathering and analysis on such issues as harmful algal blooms (HABs). Other benefits of a regional alliance include the sharing of scientific expertise and resources; reducing the duplication of efforts; pooling available, research capital toward a common goal; and promoting an ecosystem management approach as advocated by the Ocean Action Plan. Some risks may exist in developing a five-state alliance, such as ensuring that the different ecosystems within the Gulf are addressed as separate and unique, despite their broader connection to each other. Consensus building may also be challenging within the alliance, since so many different voices must be equally heard. However, the benefits to the Gulf of Mexico ecosystem with regards to nutrient loading far outweigh the potential risks associated with developing a Gulf State alliance.

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